OPERATING ENVIRONMENT

JULIAN NOTT

Nott Technology LLC, Santa Barbara
and
University of California, Santa Barbara.

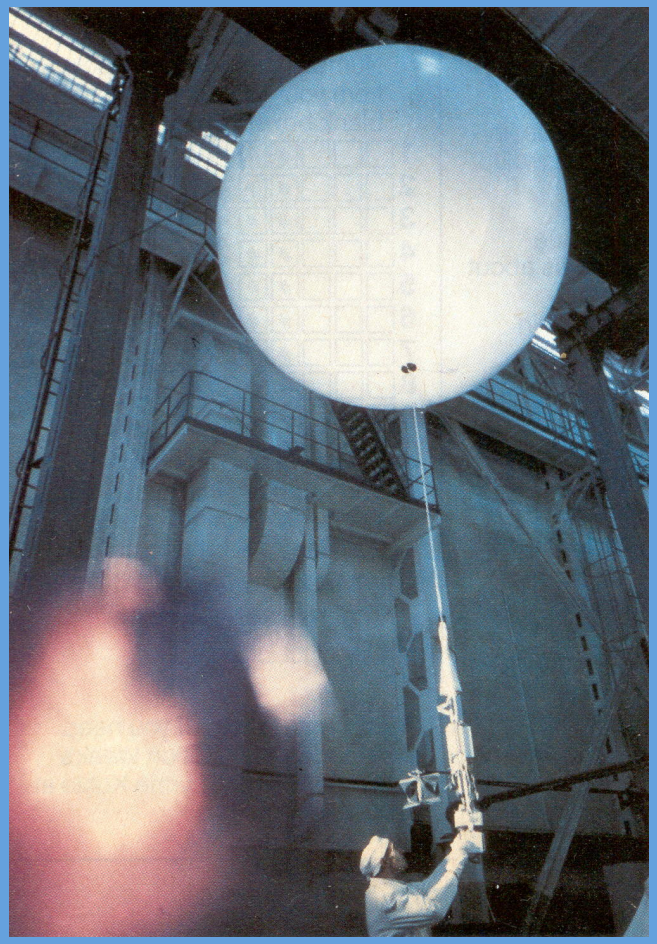
Venus Upper Atmosphere Investigations
Science and Technical Interchange Meeting
January 24 2013

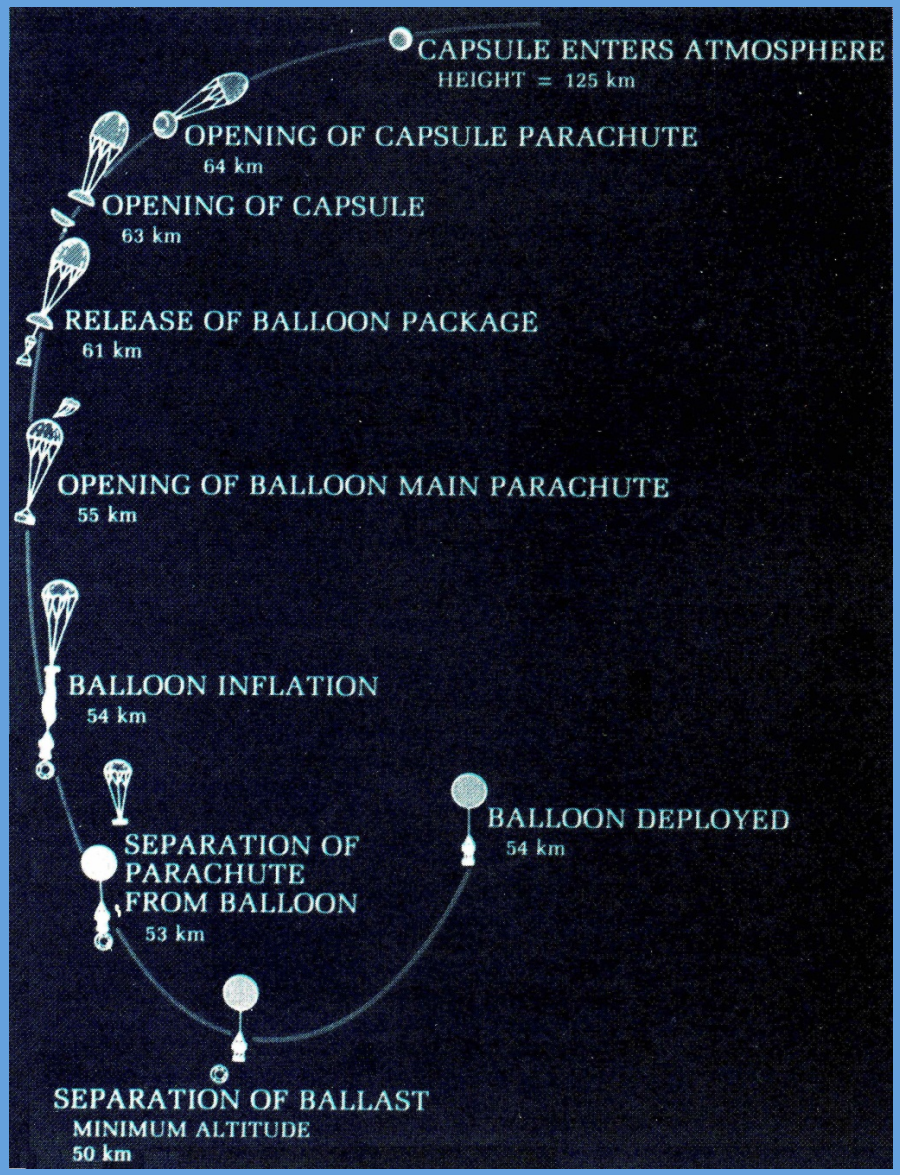
VENUS WEATHER AND ENVIRONMENT FOR BALLOONS

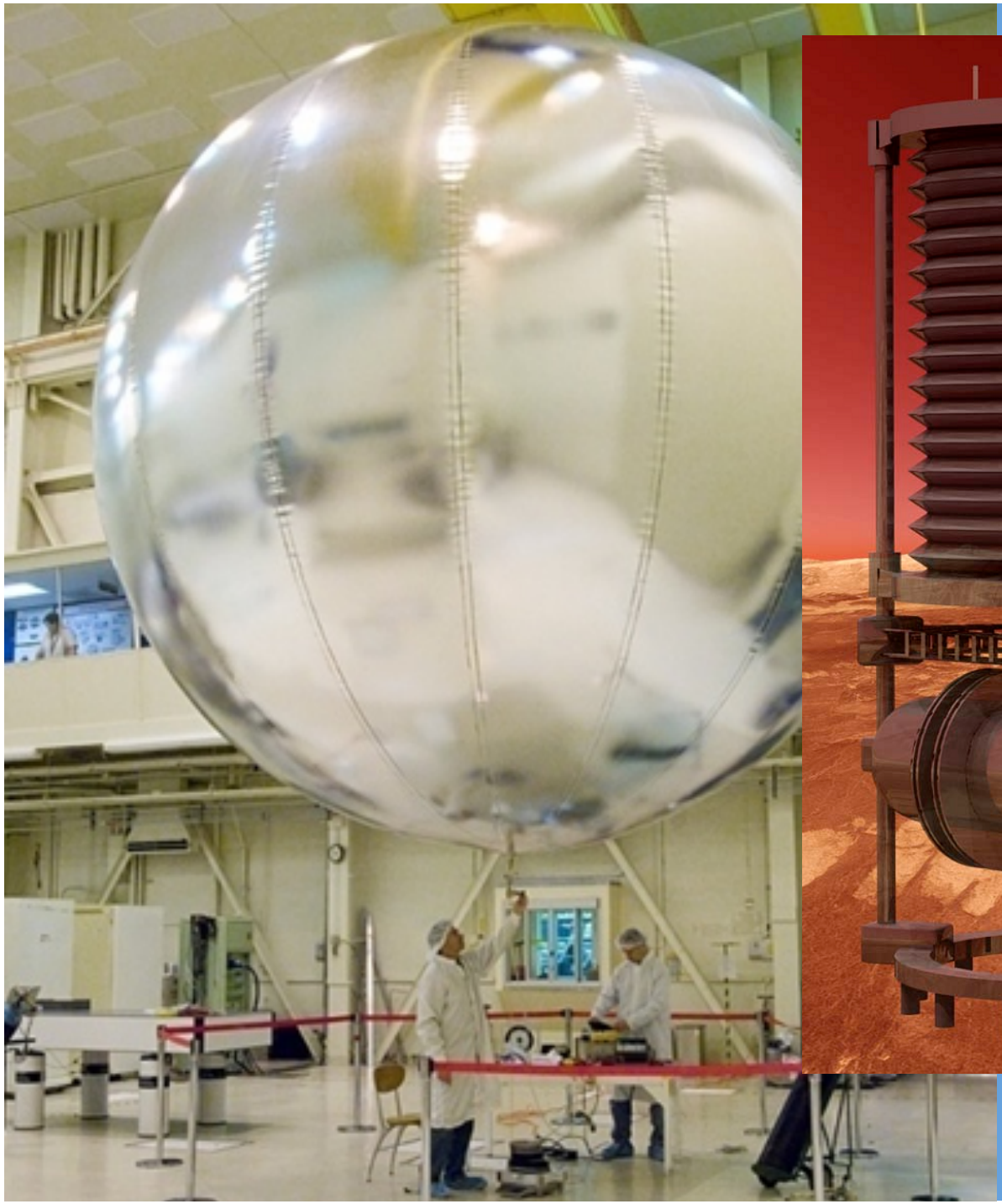
This presentation attempts to summarize what a balloon designer needs to know.

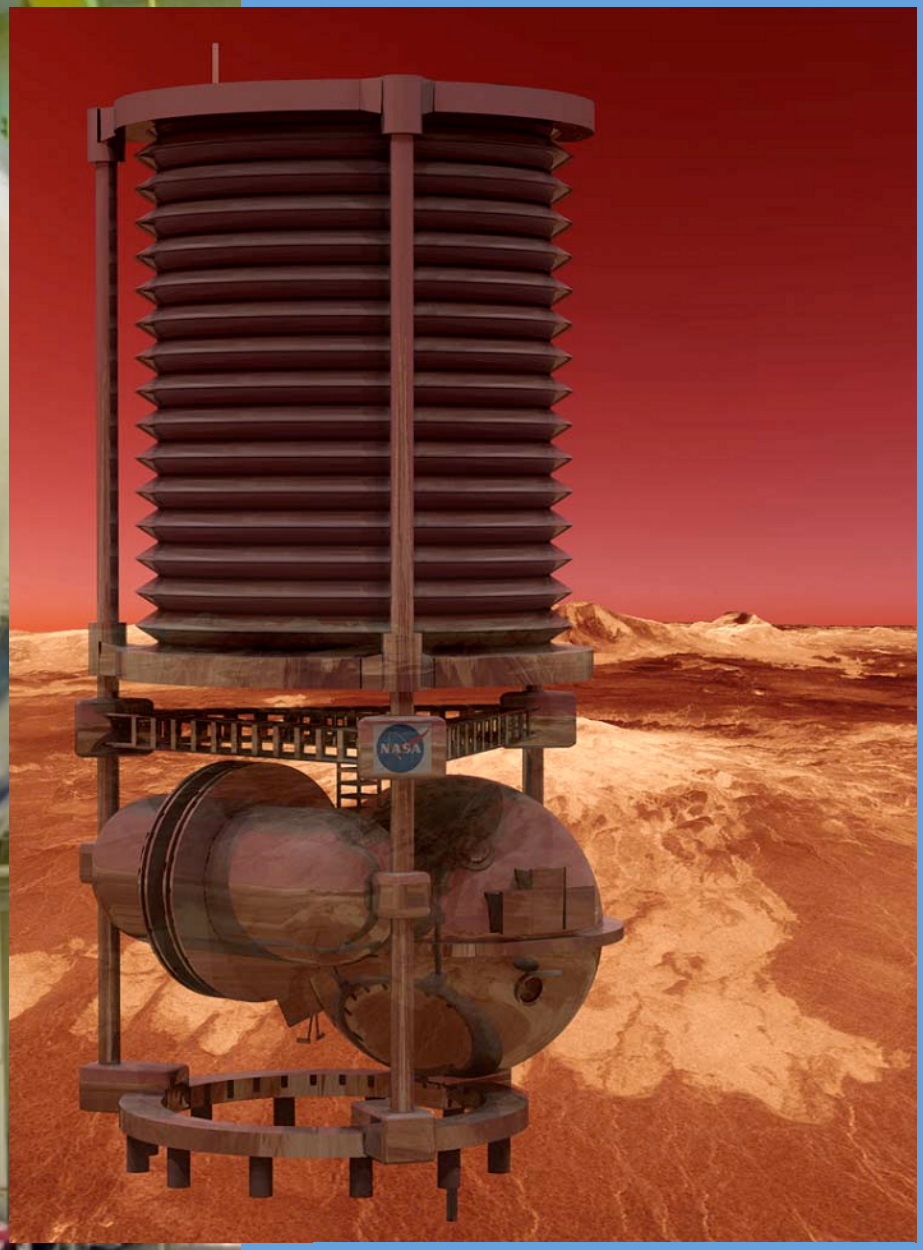
- The first questions in any balloon project are what is weather and what are the thermal conditions.
- The questions are relatively simple but the answers complex.
- Mostly of the following relates to balloons at altitudes with moderate temperatures.
- Some of it relevant to other kinds of Venus aircraft.

These charts and a summary are available on line.




CAPSULE ENTERS ATMOSPHERE
HEIGHT = 125 km
OPENING OF CAPSULE PARACHUTE
64 km
OPENING OF CAPSULE
63 km
RELEASE OF BALLOON PACKAGE
61 km
OPENING OF BALLOON MAIN PARACHUTE
55 km
BALLOON INFLATION
54 km
BALLOON DEPLOYED
54 km
SEPARATION OF PARACHUTE FROM BALLOON
53 km
SEPARATION OF BALLAST
MINIMUM ALTITUDE
50 km





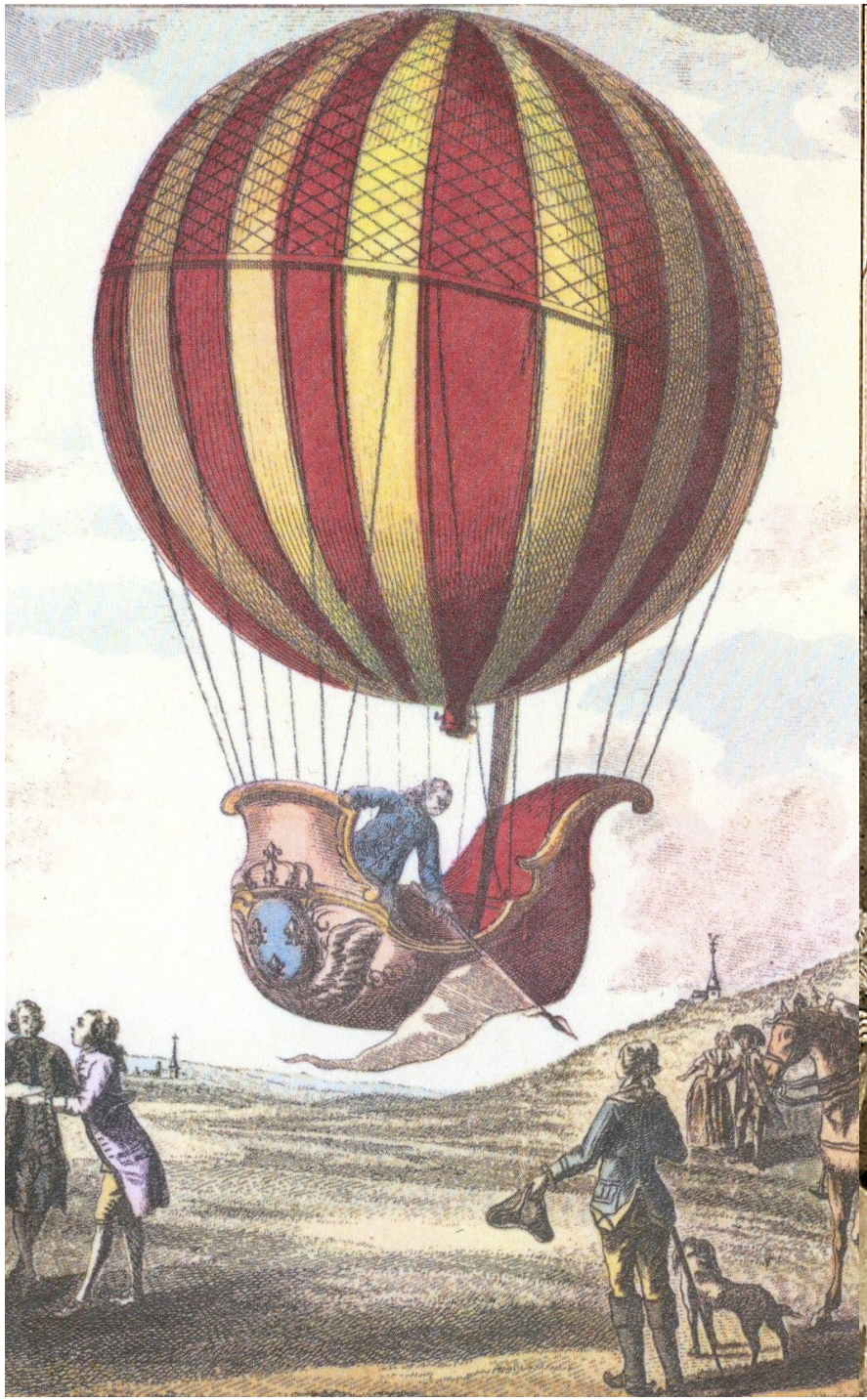
Images courtesy NASA Jet Propulsion Laboratory

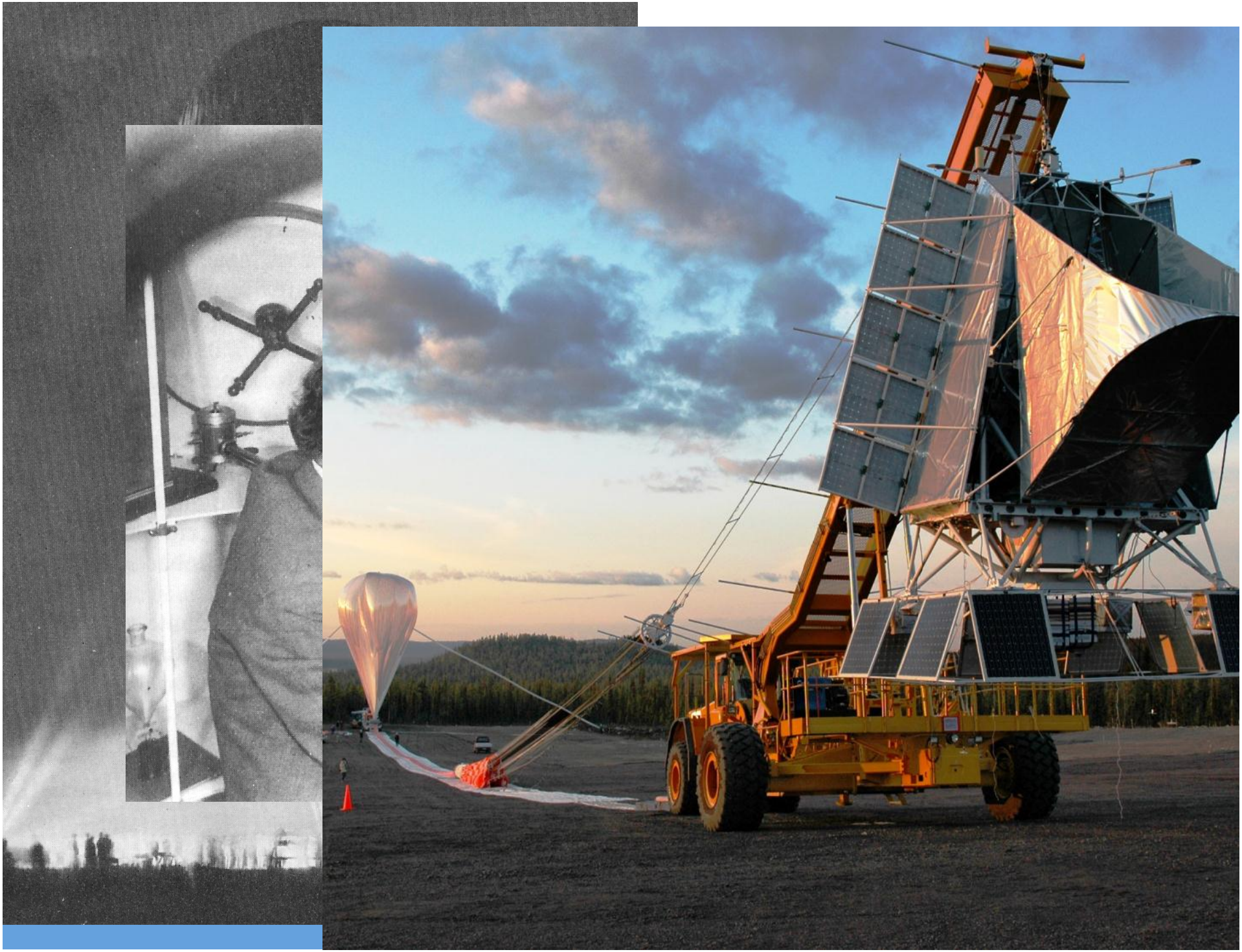
Space scientists worry that balloons are novel and risky.

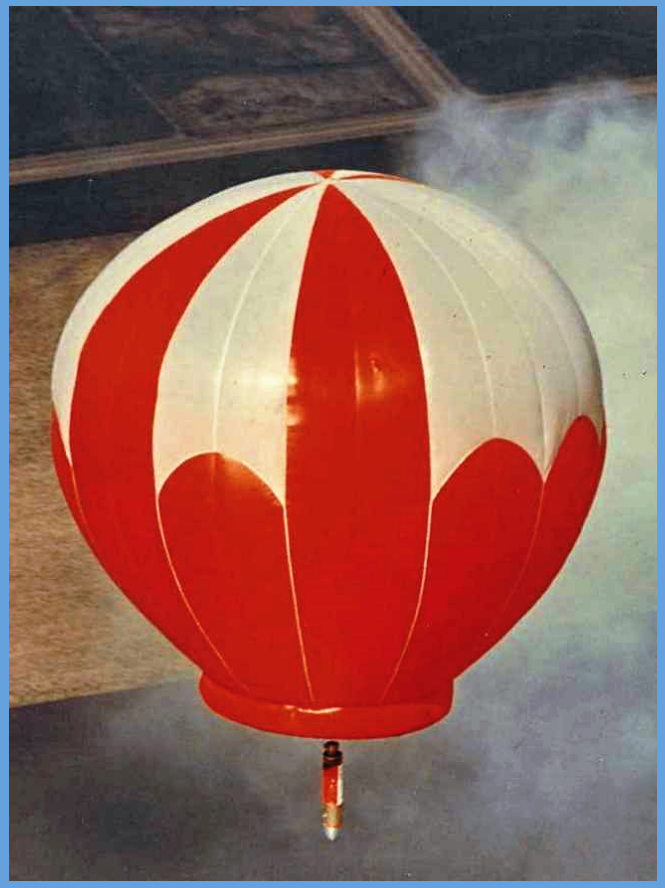
- They should not be thought of as novel spacecraft, but balloons that simply arrive via space.

- Balloons are extremely familiar. At least 50 million weather balloon launches. At least 4 million sport hot air balloon flights. Tens of thousands of flights by hydrogen and helium filled balloons.

- At altitude Venus offer conditions entirely within terrestrial experience.







Air launched balloons

Photos courtesy Rekwin Archive

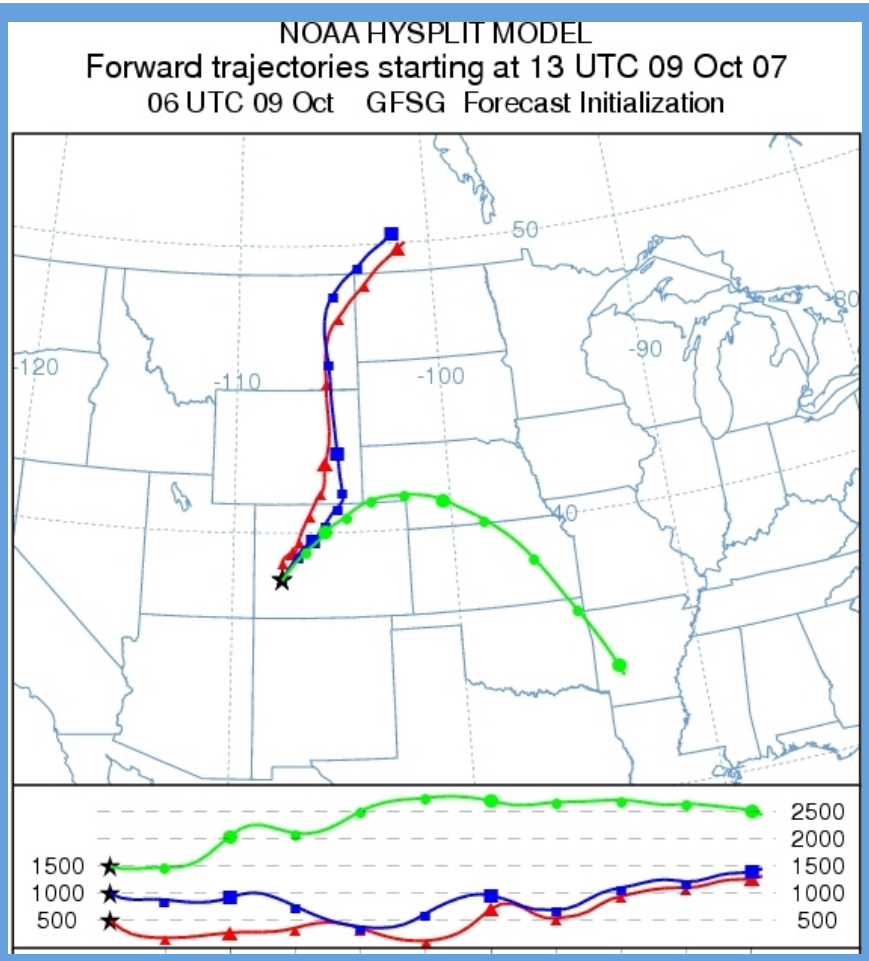
Photo set courtesy:
NASA Jet Propulsion Laboratory

WINDS

- General circulation – where will a balloon go?
- Wind speed.
- Wind structure with height:
- Wind steering.
- Dangerous wind shear.
- Vertical wind over a significant area: up and downdrafts.
- Turbulence – local wind variation.

THERMAL ENVIRONMENT – CRUCIAL TO BALLOON BEHAVIOR

- Atmosphere temperature.
- Balloon materials – strength and gas diffusion.
- Electronics.
- Solar intensity and albedo.
- Upwelling infrared.
- Nature of clouds and effect on day/night temperature swing.

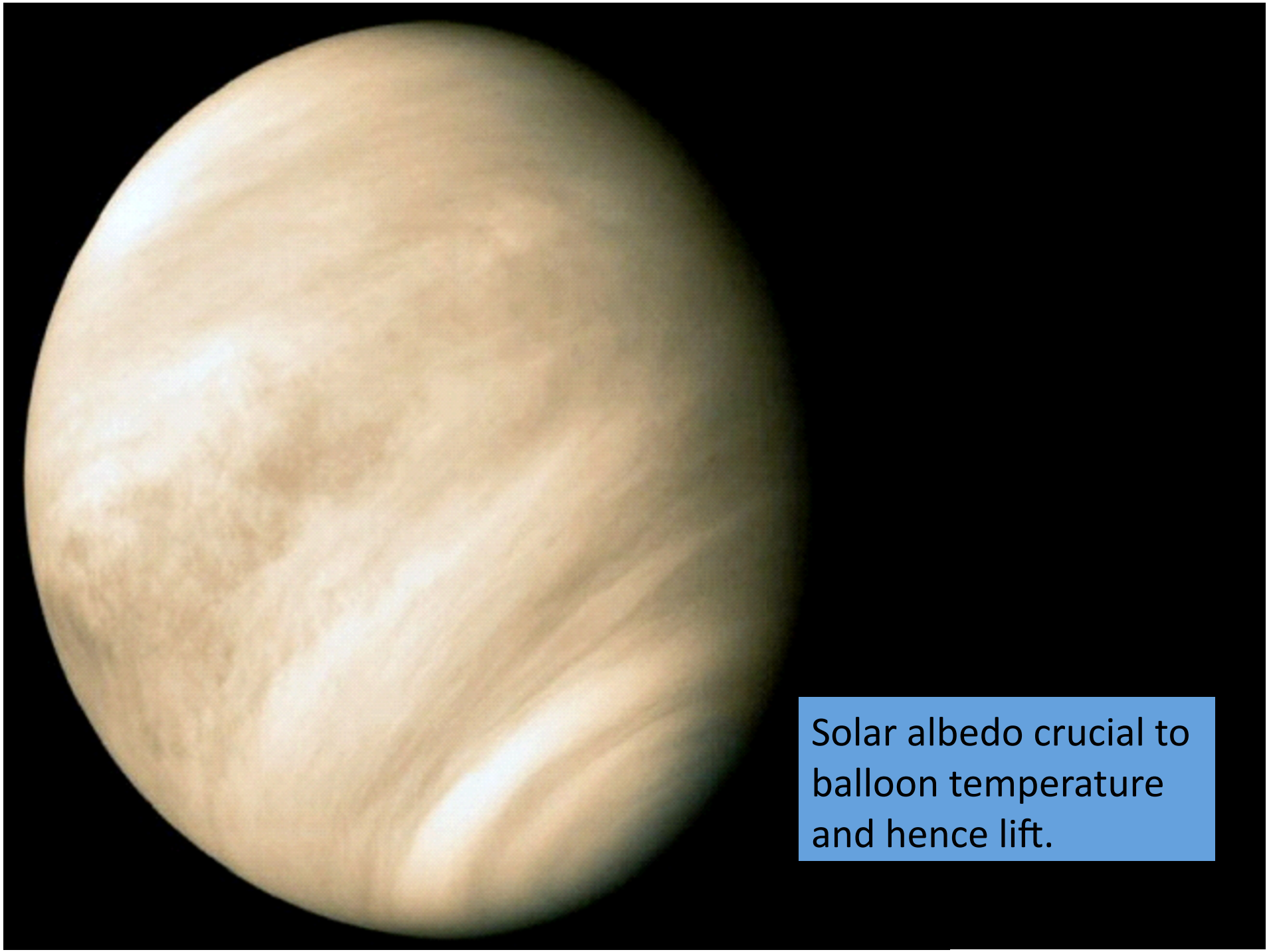


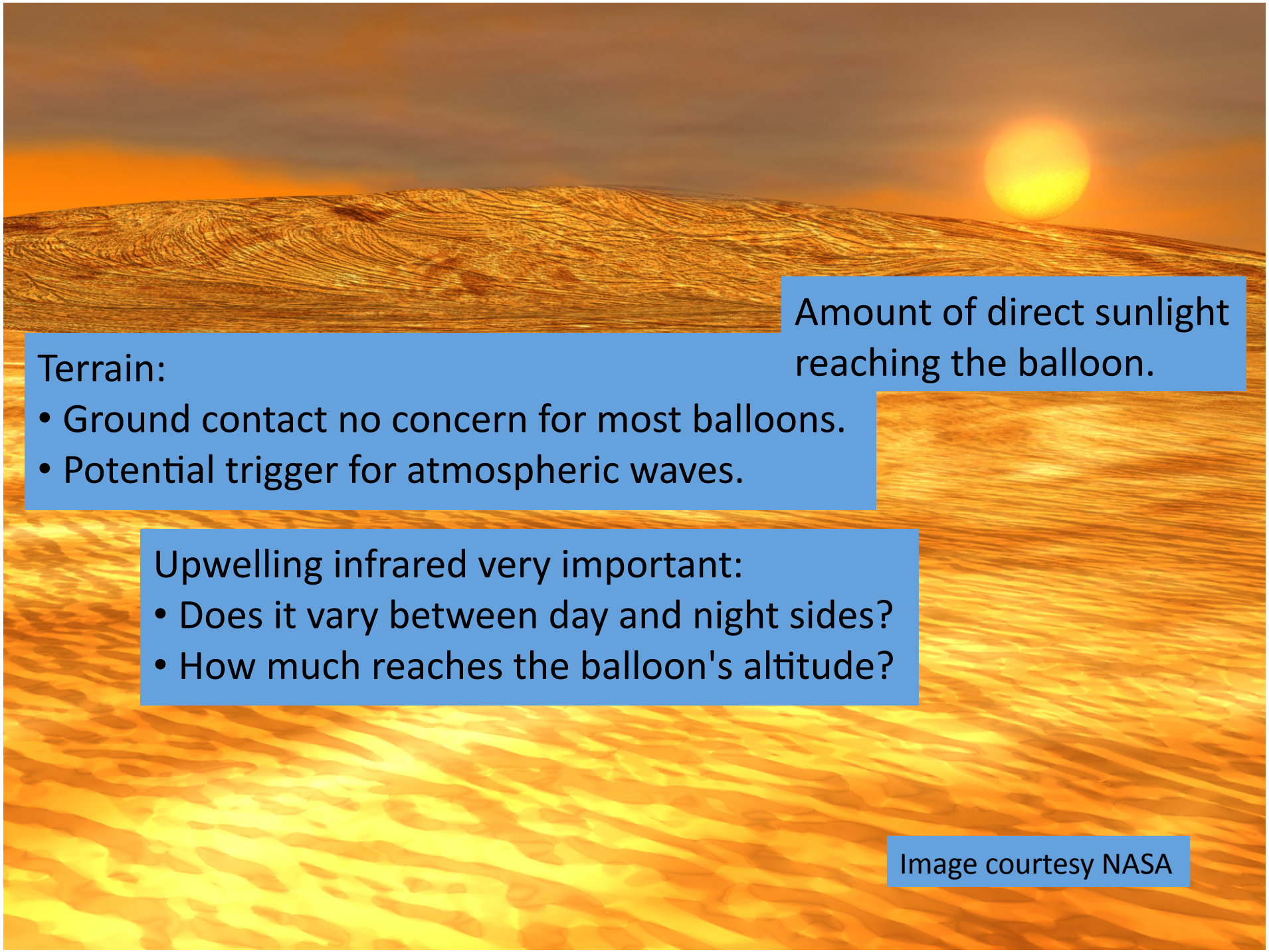
Wind steering: continental scale

"Autonomous" over 10 kilometers

Variation in wind strength and direction with altitude.

- Does variation in direction with altitude allow steering?
- With likely Venus balloons, horizontal shear only a problem if very sharp.


Solar albedo crucial to balloon temperature and hence lift.

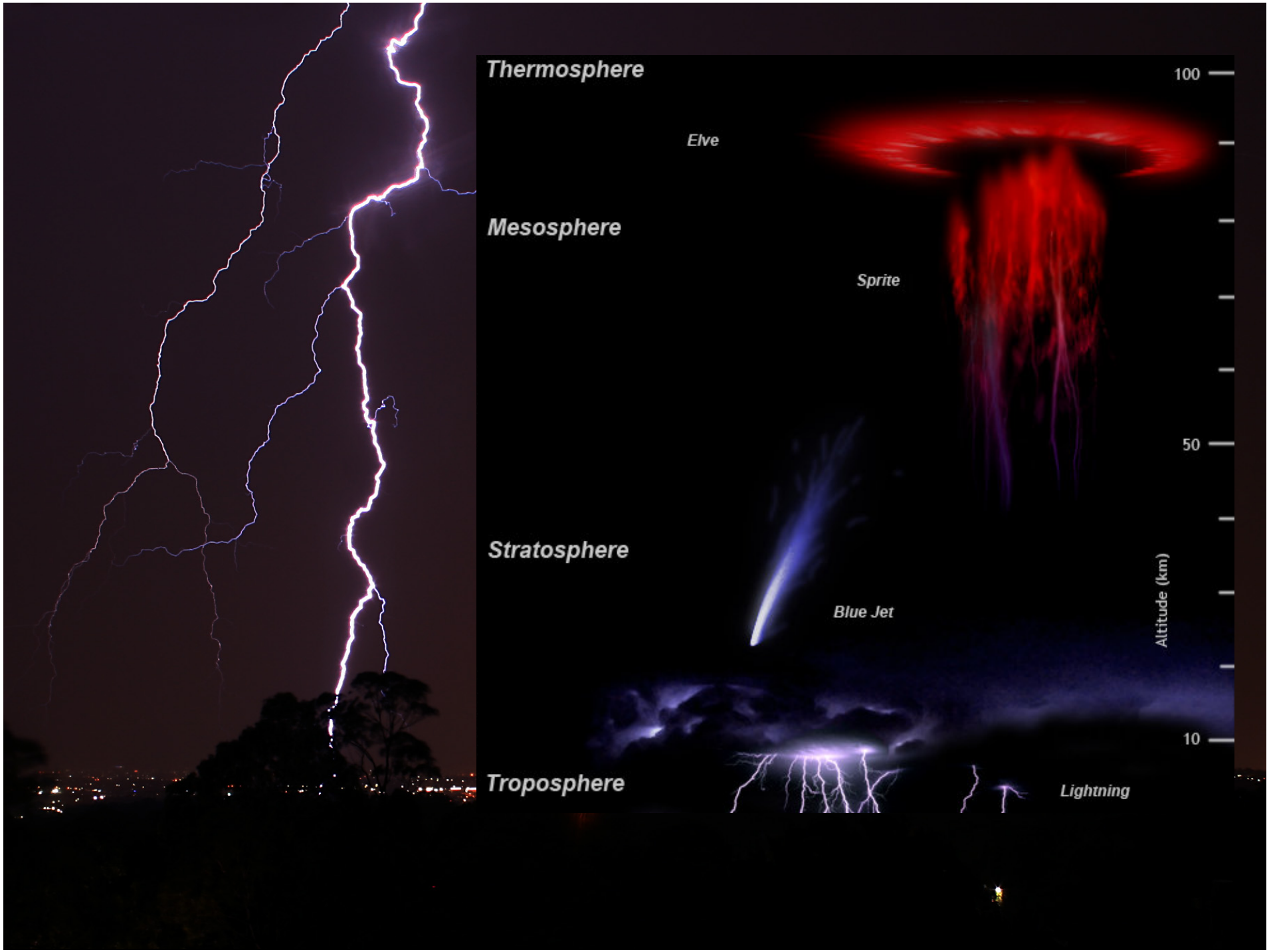

Amount of direct sunlight reaching the balloon.
Terrain:
• Ground contact no concern for most balloons.
• Potential trigger for atmospheric waves.
Upwelling infrared very important:
• Does it vary between day and night sides?
• How much reaches the balloon's altitude?
Image courtesy NASA

PRECIPITATION

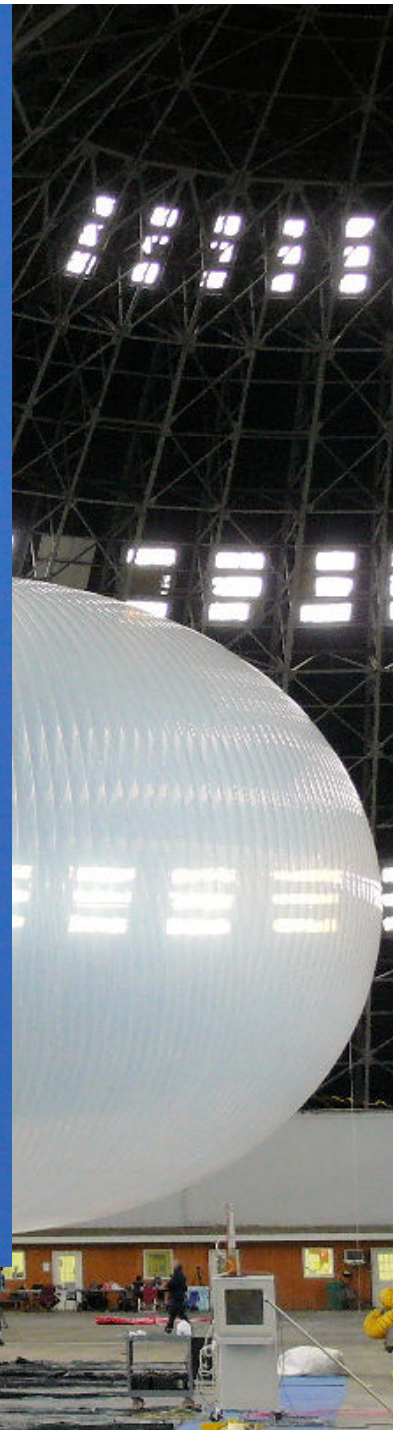
- Heavy enough to add significant weight.
- Interfere for instance with sealing of valves.
- Enough to generate turbulence or wind shear.

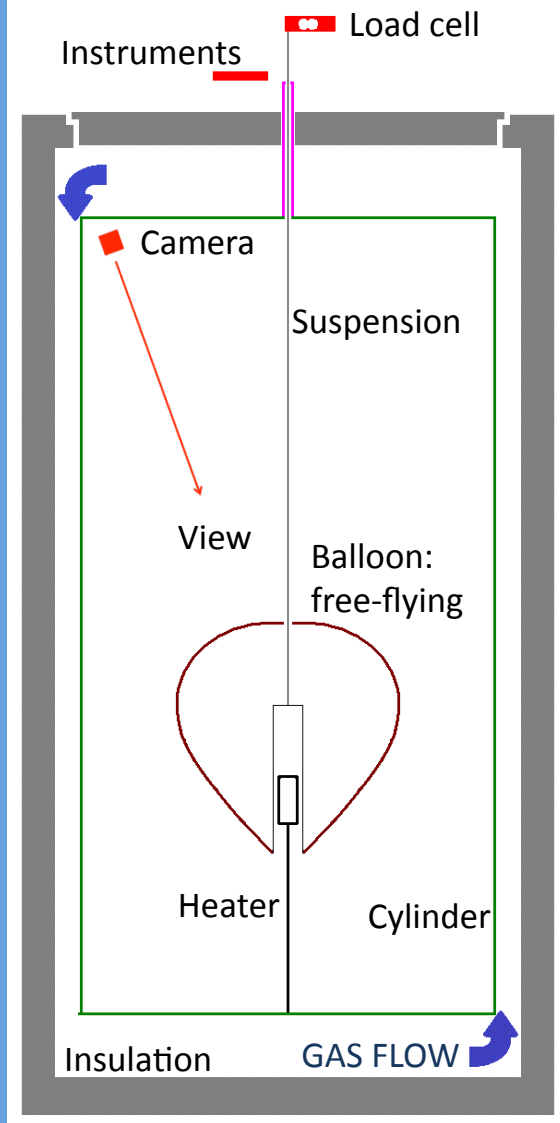
OTHER CONCERNS

- Lightning strike.
- Sulfuric acid. Added weight, corrosion.
- Seasonality - or not.
- Avoiding terrain.
- Develop strategies to cope with the inevitable uncertainties.


Thermosphere
Elve
Mesosphere
Sprite
Stratosphere
Blue Jet
Troposphere
Lightning
100
50
10
Altitude (km)

At 110,000 ft: telescope picture



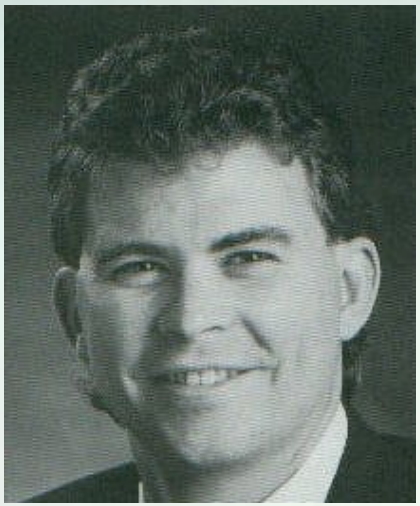


The Titan Sky Simulator™

Looking down: balloon flying at *minus* 180C.

Launching from Albuquerque into the night and into the mountains…

The forecaster is a crucial.



Don Day
President - Meteorologist
DayWeather Inc.

CONTACTS

Julian Nott, Nott Technology LLC
Santa Barbara, California
nott@nott.com +1.805.708.8100

Don Day, President - Meteorologist
DayWeather, Inc.
Cheyenne, Wyoming
Don@DayWeather.com

Dr Jeff L. Hall
NASA Jet Propulsion Laboratory
jeffery.l.hall@jpl.nasa.gov

Download this presentation including these contacts:

www.NOTT.com/venus